

## Claims

What is claimed is:

1. A system for finding the instantaneous spatial direction of a source of radio signals comprising  
A plurality of antennas;  
A plurality of Radio Frequencies receivers, equal the number of antennas;  
A plurality of phase digitizers, equal the number of antennas;  
Devices to digitally calculate the the phase difference between ant two antennas;  
Devices to digitally calculate the instantaneous frequency of a detected signal;  
Devices to digitally calculate, from frequency and phase differences data, the azimuth of a source of radio signal.
2. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 1, wherein the plurality of antennas is a minimum of three antennas.
3. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 1, wherein each antenna connects to a receiver.
4. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 1, wherein each receiver generates in response to a signal received from an antenna, two output signals at a frequency within the operating bandwidth of half the clock frequency, and wherein the phase difference between the two signals is about 90°.
5. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 1, wherein each phase digitizer connects to one receiver, and generates in response to signals received from the receiver a digital output indicative of the instantaneous phase of the signals received from the receiver, at the instance of the transition of an instruction clock pulse.
6. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 1, wherein the devices used to calculate the phase differences between antennas comprise of digital substractors and adders.
7. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 1, wherein the instantaneous frequency can be calculated by digitally obtaining of the phase difference in a signal received, over a span of a single clock period.
8. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 1, wherein the results of frequency and phase differences calculations may be improved by averaging of digital data generated over a plurality of clock periods.
9. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals comprising  
A plurality of antennas on a horizontal plane;  
An additional antenna;  
A plurality of Radio Frequencies receivers, equal the number of antennas;  
A plurality of phase digitizers, equal the number of antennas;  
Devices to digitally calculate the the phase difference between ant two antennas;  
Devices to digitally calculate the instantaneous frequency of a detected signal;  
Devices to digitally calculate, from frequency and phase differences data, the azimuth of a source of radio signal.
10. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 9, wherein the plurality of antennas on a horizontal plane is a minimum of three antennas
11. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 9, wherein an additional antenna is erected on a vertical axis common with one antenna on the horizontal plane.
12. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 9, wherein each antenna connects to a receiver.
13. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 9, wherein each receiver generates in response to a signal received from

- an antenna, two output signals at a frequency within the operating bandwidth of half the clock frequency, and wherein the phase difference between the two signals is about 90°.
14. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 9, wherein each phase digitizer connects to one receiver, and generates in response to signals received from the receiver a digital output indicative of the instantaneous phase of the signals received from the receiver, at the instance of the transition of an instruction clock pulse.
  15. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 9, wherein the devices used to calculate the phase differences between antennas comprise of digital subtractors and adders.
  16. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 9, wherein the instantaneous frequency can be calculated by digitally obtaining of the phase difference in a signal received, over a span of a single clock period.
  17. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 9, wherein the results of frequency and phase differences calculations may be improved by averaging of digital data generated over a plurality of clock periods.
  18. A system for finding the instantaneous spatial direction of a source of radio signals comprising
    - A four antennas;
    - A four Radio Frequencies receivers;
    - A four phase digitizers;
    - Devices to digitally calculate the the phase difference between ant two antennas;
    - Devices to digitally calculate the instantaneous frequency of a detected signal;
    - Devices to digitally calculate, from frequency and phase differences data, the azimuth of a source of radio signal.
  19. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 18, wherein four antennas are mounted on a horizontal plane.
  20. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 18, wherein four antennas are mounted on a horizontal plane as two pairs of antennas wherein each pair of antennas is mounted on one common axis, and further wherein the axes of the two pairs of antennas are perpendicular to each other.
  21. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 18, wherein each antenna connects to a receiver.
  22. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 18, wherein each receiver generates in response to a signal received from an antenna, two output signals at a frequency within the operating bandwidth of half the clock frequency, and wherein the phase difference between the two signals is about 90°.
  23. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 18, wherein each phase digitizer connects to one receiver, and generates in response to signals received from the receiver a digital output indicative of the instantaneous phase of the signals received from the receiver, at the instance of the transition of an instruction clock pulse.
  24. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 18, wherein the devices used to calculate the phase differences between antennas comprise of digital subtractors and adders.
  25. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 18, wherein the instantaneous frequency can be calculated by digitally obtaining of the phase difference in a signal received, over a span of a single clock period.
  26. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 18, wherein the results of frequency and phase differences calculations may be improved by averaging of digital data generated over a plurality of clock periods.
  27. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals comprising
    - Four antennas on a horizontal plane;
    - An additional antenna;
    - A four Radio Frequencies receivers;

- A four phase digitizers;  
 Devices to digitally calculate the the phase difference between ant two antennas;  
 Devices to digitally calculate the instantaneous frequency of a detected signal;  
 Devices to digitally calculate, from frequency and phase differences data, the azimuth of a source of radio signal.
28. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 27, wherein four antennas are mounted on a horizontal planeas two pairs of antennas wherein each pair of antennas is mounted on one common axis, and further wherein the axes of the two pairs of antennas are perpendicular to each other.
  29. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 27, wherein an additional antenna is erected on a vertical axis common with one antenna on the horizontal plane.
  30. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 27, wherein each antenna connects to a receiver.
  31. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 27, wherein each receiver generates in response to a signal received from an antenna, two output signals at a frequency within the operating bandwidth of half the clock frequency, and wherein the phase difference between the two signals is about 90°.
  32. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 27, wherein each phase digitizer connects to one receiver, and generates in response to signals received from the receiver a digital output indicative of the instantaneous phase of the signals received from the receiver, at the instance of the transition of an instruction clock pulse.
  33. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 27, wherein the devices used to calculate the phase differences between antennas comprise of digital subteractors and adders.
  34. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 27, wherein the instantaneous frequency can be calculated by digitally obtaining of the phase difference in a signal received, over a span of a single clock period.
  35. A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals as in claim 27, wherein the results of frequency and phase differences calculations may be improved by averaging of digital data generated over a plurality of clock periods.
  36. A system for finding the instantaneous spatial direction of a source of radio signals comprising
    - Two directional antennas;
    - Two radio signals receivers, equal the number of antennas;
    - Two phase digitizers, equal the number of antennas;
    - Devices to digitally calculate the the phase difference between the two antennas;
    - Devices to digitally calculate the instantaneous frequency of a detected signal;
    - Devices to digitally calculate, from frequency and phase differences data, the azimuth of a source of radio signal.
  37. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 36, wherein each antenna connects to a receiver.
  38. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 36, wherein each receiver generates in response to a signal received from an antenna, two output signals at a frequency within the operating bandwidth of half the clock frequency, and wherein the phase difference between the two signals is about 90°.
  39. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 36, wherein each phase digitizer connects to one receiver, and generates in response to signals received from the receiver a digital output indicative of the instantaneous phase of the signals received from the receiver, at the instance of the transition of an instruction clock pulse.
  40. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 36, wherein the devices used to calculate the phase differences between antennas comprise of digital subtrctors and adders.

41. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 36, wherein the instantaneous frequency can be calculated by digitally obtaining of the phase difference in a signal received, over a span of a single clock period.
42. A system for finding the instantaneous spatial direction of a source of radio signals as in claim 36, wherein the results of frequency and phase differences calculations may be improved by averaging of digital data generated over a plurality of clock periods.
43. A monopulse type radar system comprised of one, two, or three directional antennas, wherein the instantaneous phase of received radio signals is measured using phase digitizers.
44. A "cross-eye" radar deception system comprised of
  - Two directional antennas;
  - Two radio signals receivers;
  - Two phase digitizer;
  - Two temporary memories;
  - Two digital phase shifters;
  - A common digital signal processing and control unit.
45. A "cross-eye" radar deception system as in claim 44, wherein the instantaneous phase of a signal received on the antenna is measured utilizing a phase digitizer.
46. A "cross-eye" radar deception system as in claim 44, wherein the temporary memory stores consecutive samples of the instantaneous phase of the signal received on the antenna.
47. A "cross-eye" radar deception system as in claim 44, wherein instantaneous phase data stored in the memory, can be read back from the temporary memory in the same order in which that data was stored in the memory, and wherein such readback may comprise of a one time readback, or repeated head to tail readbacks.
48. A "cross-eye" radar deception system as in claim 44, wherein the common digital signal processing and control unit receives the digital presentation of the instantaneous phase of radio signals received on both antennas and digitized by the corresponding phase digitizers, and wherein the digital signal processing unit measures the instantaneous phase difference between signals received on both antennas, and controls the digital phase shifters.
49. A "cross-eye" radar deception system as in claim 44, wherein the digital phase shifters receive digital phase shift commands from the digital signal processing unit and in response modifies the data readback from the memory to cause a shift in the phase of the signal at the output of a phase to analog converter.
50. A "cross-eye" radar deception system as in claim 44, wherein the phase to analog converters receives instantaneous phase data from the digital phase shifter and convert that data into a succession of analog pulses of an amplitude directly proportional to the arcsine of the instantaneous phase as presented by the instantaneous phase data at the input to the converter.

## **Abstract**

A system for finding the instantaneous spatial azimuth and elevation of a source of radio signals employing phase digitizers to measure the phase of arrival of a radio signal on an array of antennas. The phase digitizers providing digital indication of the phase of arrival, enable the determination of the azimuth, and elevation of a source of radio signal, utilizing simple digital subtraction methods.